Christian-Albrechts-Universität zu Kiel
Mathematisch-Naturwissenschaftliche Fakultät

EOM Earth Observation and Modelling

Comparison of Atmospheric Parameters

Derived from *In-Situ* and Hyperspectral Remote Sensing Data of Beautiful Bavarian Lakes

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Test Sites and Goal

Test area: lake Starnberg and Klostersee (near Munich)
Goal: compare derived parameters (Aerosol optical thickness, Angstrom exponent, water vapor column and ozone column) from *in-situ* data collected during a measurement campaign with spectra and parameters derived from HySpex (hyperspectral airborne imager) and Sentinel-2A images.
Field instruments: Microtops sunphotometer, Ibsen field spectrometer, RAMSES (TriOS) system
Imaging sensors: HySpex (Klostersee), Sentinel-2A (Lake Starnberg)

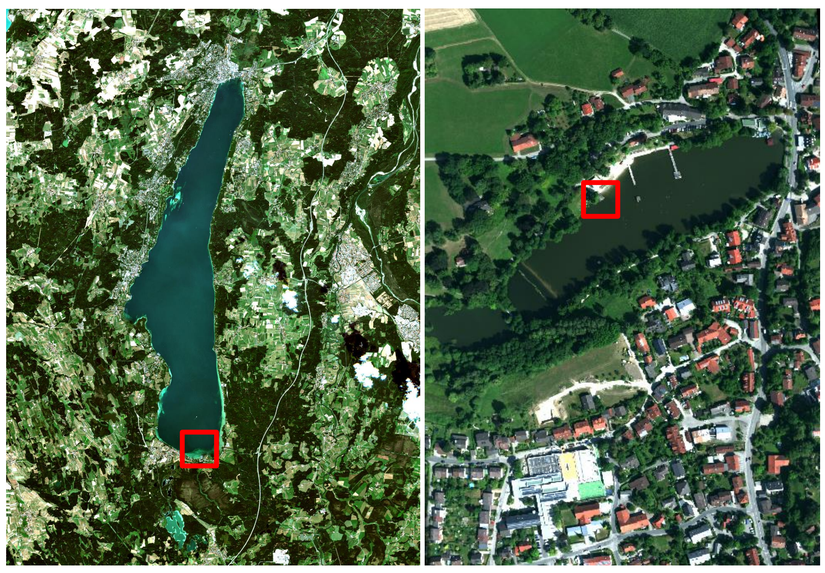

Fig. 1: **Left**: section of the used Sentinel-2A scene containing Lake Starnberg. **Right**: section of the used HySpex scene containing the Klostersee. Test areas are marked with a red square.

Conclusion

- Aerosol parameters are generally in good agreement
- High differences in H_2O and O_3 absorption between *in-situ* and hyperspectral data
- Validation of atmospheric parameters derived from multi-/hyperspectral remote sensing data with *in-situ* measurements is very valuable
- Final interpretation of the observed differences requires further investigations

Fig. 2: The *in-situ* measurement team while preparing the boat at the Lake Starnberg test site. The RAMSES system is suspended from the white crane-like arm.

Deriving atmospheric parameters from in-situ and remote sensing data

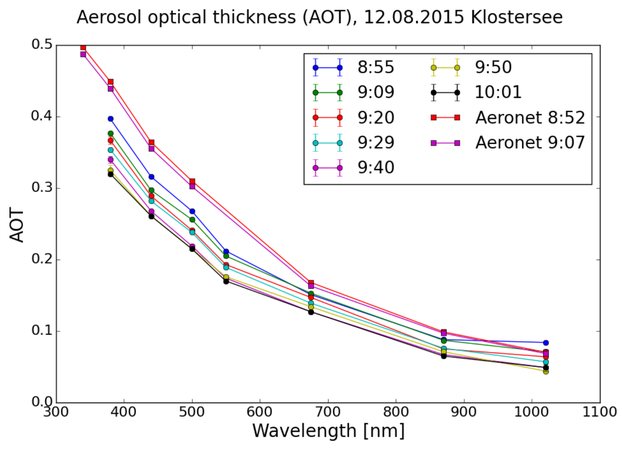

Fig. 3: Aerosol optical thickness (AOT) values at different wavelengths and times derived from Microtops (sunphotometer) measurements. For comparison two Cimel sunphotometer measurements (Aeronet station at Hohenpeissenberg) are included into the plot.

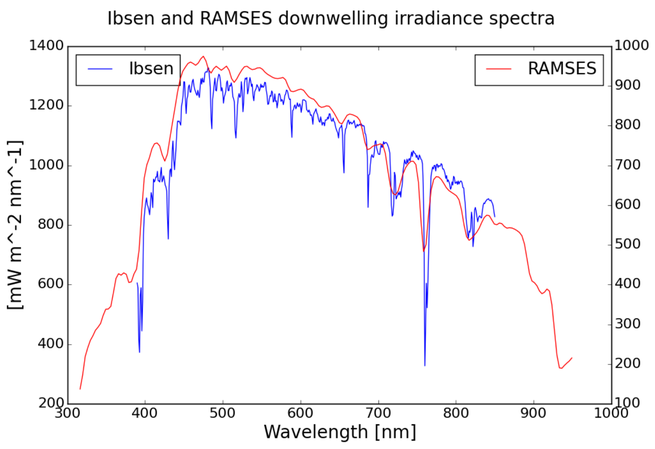

Fig. 4: Downwelling irradiance (E_D) measurements for validation of the Lake Starnberg Sentinel-2A data. Red curve: data from the RAMSES irradiance sensor (resolution$_{FWHM}$ = 12 nm; 3.3 nm sampling distance). Blue curve: Downwelling irradiance on a spectralon panel measured with an Ibsen spectrometer (resolution$_{FWHM}$ = 1.6 nm; 0.5 nm sampling distance).

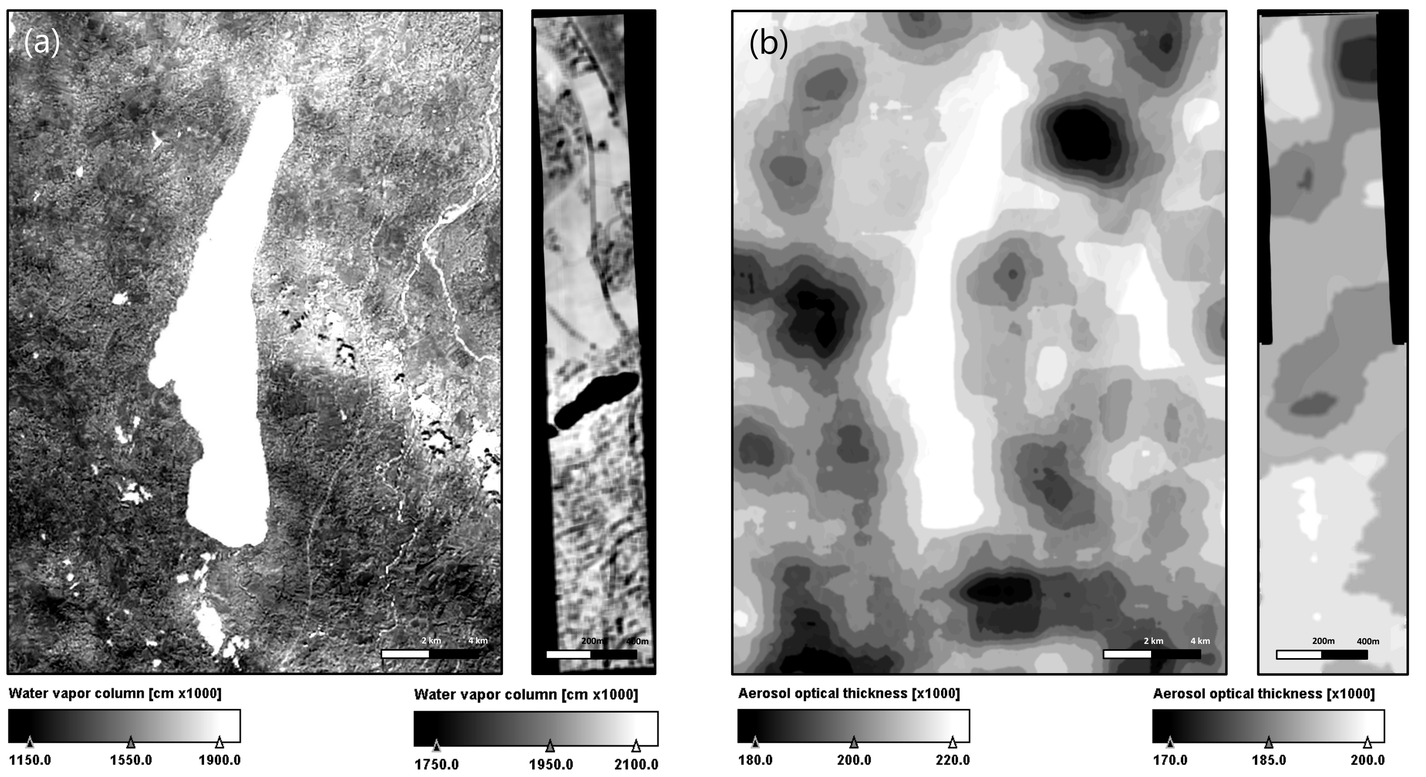

Fig. 5: **(a)** Water vapor map of Lake Starnberg (left) derived from Sentinel-2A data and Klostersee (right) derived from HySpex data. Over the water areas water vapor is set constant. **(b)** Same as (a) for Aerosol optical thickness at 550 nm.

(a) and (b): average values for comparison have been derived over land surface close to the test areas.

Custom analytical evaluation and Aeronet[4] website → AOT 550 nm, Angstrom exp., Water vapor, Ozone

WASI[1] fitting → Water vapor, Ozone

ATCOR[3] and Sen2Cor[2] → AOT 550 nm, Water vapor

Comparison of atmospheric parameters

Lake Starnberg: comparison of atmospheric parameters **Sentinel-2A** overflight 13.08.2015, 10:16 UTC					
	Microtops (10:17)	Ibsen E_d (10:08)	Ramses E_d (9:54)	Sentinel-2A (10:16)	Aeronet (10:22)
AOT 550 nm	0.151 (interpolated)	-	-	0.205±0.003	0.168 (interpolated)
Angstrom exponent	1.89	-	-	-	1.94 (440-675nm)
Water vapor column	0.93	1.03±0.01	1.02	1.52±0.12	1.44
Ozone column	0.324±0.002	0.459±0.07	0.398	-	-

Table 1: **Left**: parameter comparison for the Lake Starnberg test site. **Right**: parameter comparison for the Klostersee test site. The colored values denote the credibly of the value judged by the authors. Red: likely erroneous. Orange: maybe erroneous. Green: probably close to reality.

Klostersee: comparison of atmospheric parameters **Hyspex** overflight 12.08.2015, 8:57 and 9:04 UTC				
	Microtops (8:55/9:09)	Ramses E_d (9:46)	Hyspex (8:57/9:04)	Aeronet (8:52/9:07)
AOT 550 nm	0.212/0.205 (interpolated)	-	0.197±0,003/ 0.192±0.003	0.260/0.253 (interpolated)
Angstrom exponent	1.83±0.01/ 1.75	-	-	1.84/1.86 (440-675nm)
Water vapor column	0.96±0.02/ 0.99	0.93±0.01	2.06±0.07/ 2.02±0.07	1.69
Ozone column	0.323±0.002/ 0.326	0.387±0.002	-	-

- Generally good agreement for aerosol parameters
- Not very good agreement for H_2O and O_3 absorption
- Values derived from hyperspectral data always higher than *in-situ* values

- Errors are statistical, do not reflect systematic instrument errors
- Values without errors from measurements, upon which no statistics can be applied
- Aeronet distance to Lake Starnberg: 23 km; to Klostersee: 78 km

[1] Kiel University
[2] German Aerospace Center (DLR)

References
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